

Wind Powering America and Federal Wind Energy Initiatives

Honolulu, HI
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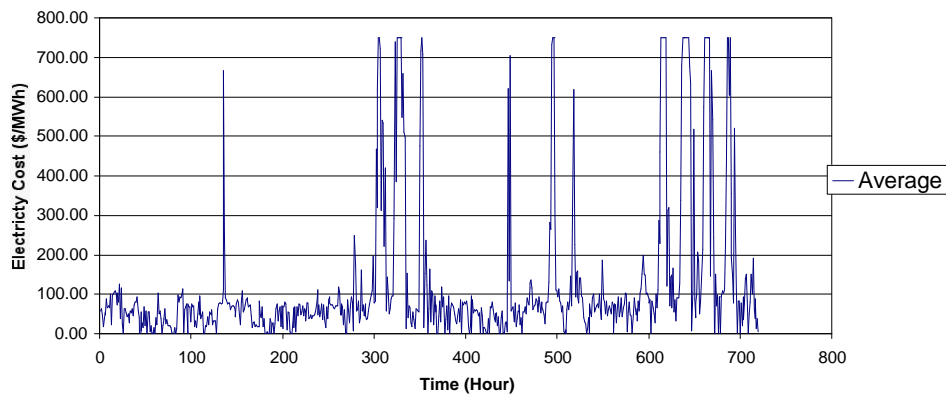
National Wind Technology Center



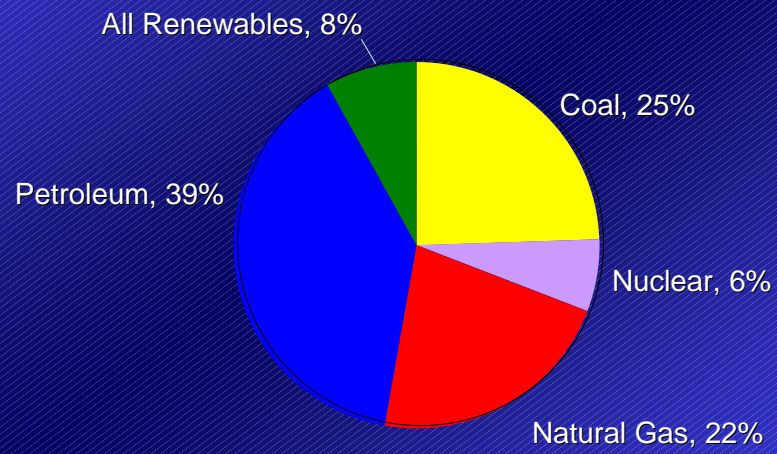
Industrial User Facility

Recent Electricity Price Volatility

Figure 1: California ISO Real Time Prices -- (June 2000)

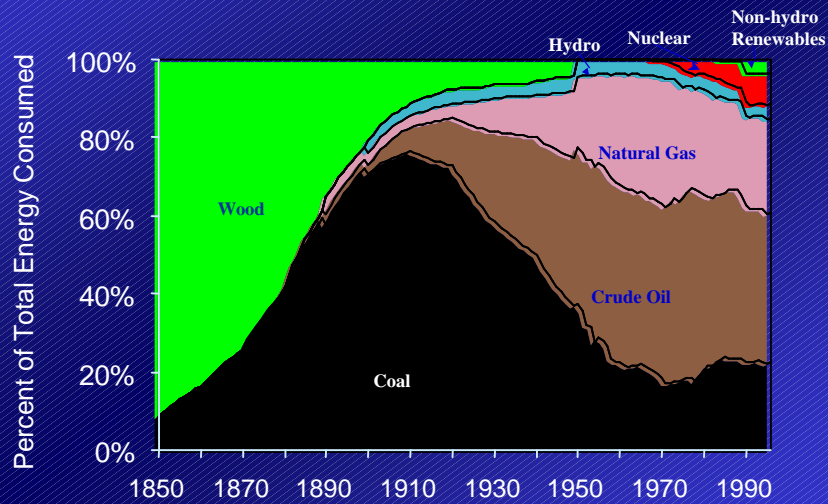


Worldwide Energy Consumption By Source - 1997



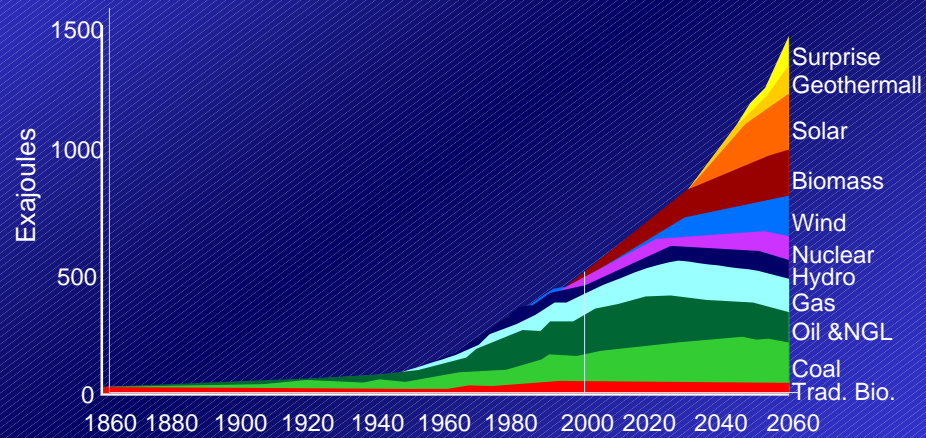
Source: Energy Information Administration, *International Energy Outlook 2000*, Table A2

U.S. Energy Production by Source 1850-1996



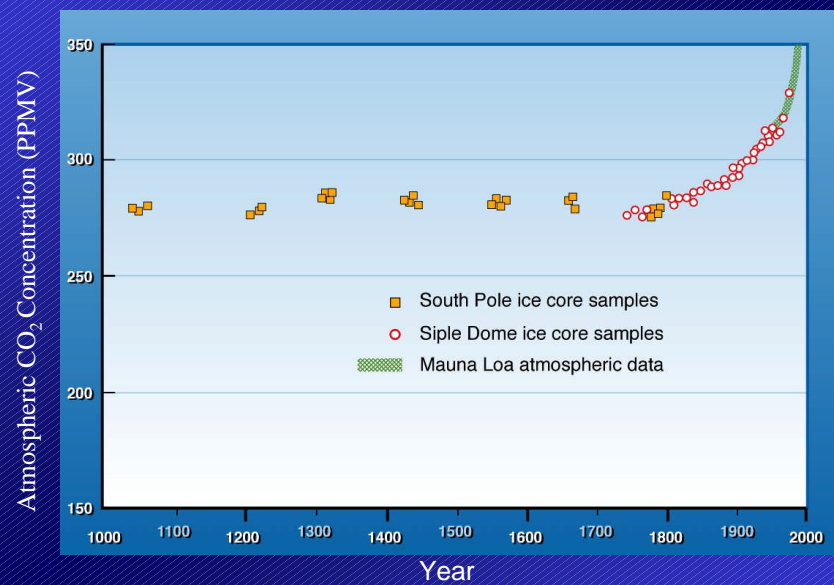
Source: 1850-1949, Energy Perspectives: A Presentation of Major Energy and Energy-Related Data, U.S. Department of the Interior, 1975; 1950-1996, Annual Energy Review 1996, Table 1.3. Note: Between 1950 and 1990, there was no reporting of non-utility use of renewables

Shell Sustained Growth Scenario



Source: Shell, *The Evolution of the World's Energy Systems*, 1995

Atmospheric Concentration of CO₂



Source: Adapted from W.M. Post, T.H. Peng, W.R. Emanuel, A.W. King, V.H. Dale, and D. DeAngelis. *American Scientist*, 1990. "The Global Carbon Cycle."

Renewable Energy Pathways

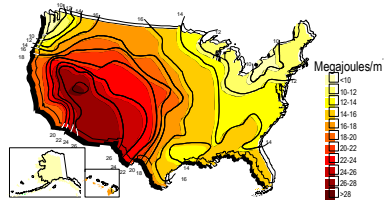
- v Wind Energy
- v Solar Photovoltaics
- v Solar Thermal Electric
- v Solar Buildings
- v Biomass Electric
- v Biomass Transportation Fuels
- v Geothermal Energy
- v Hydropower
- v Solar Advanced Photoconversion



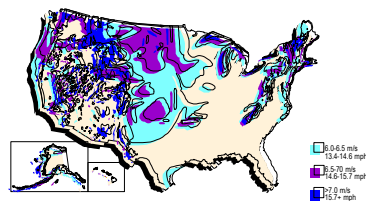
Source: Technology Opportunities to Reduce U.S. Greenhouse Gas Emissions, Oct 1997

U.S. Renewable Energy Resources

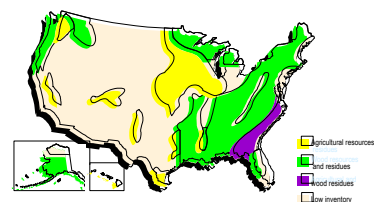
Solar



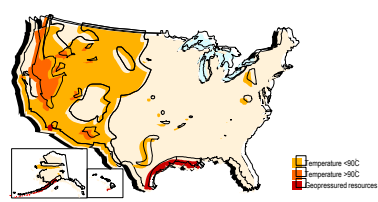
Wind



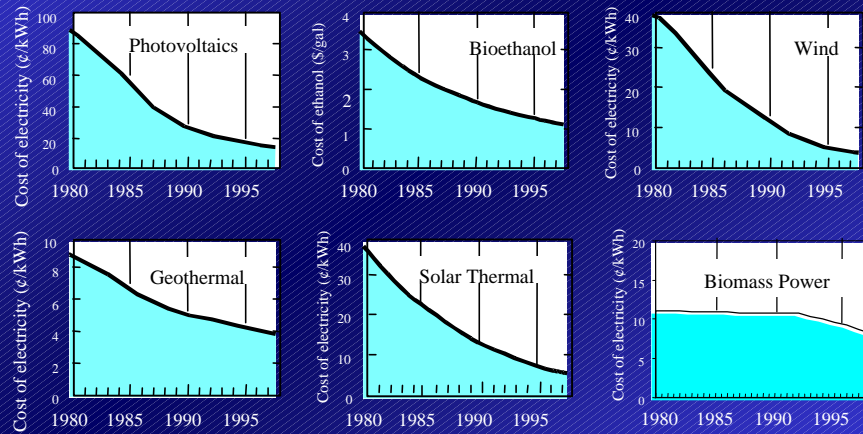
Biomass



Geothermal



Renewable Energy Cost Trends



Source: Billman, Advances in Solar Energy submission, 1/8/99

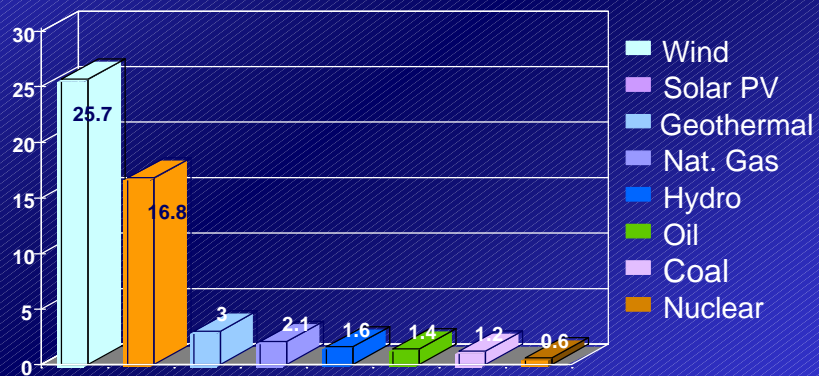
Wind Energy is the Star of the Green Market

- v Environmental Benefit
- v Popular
- v Visual Appeal
- v Hydro and Gas Resources Complementary
- v Modular
- v Cost-Competitive



Fastest Growing Energy Source in the World

Global Growth by Energy Source, Annual Average, 1990-98

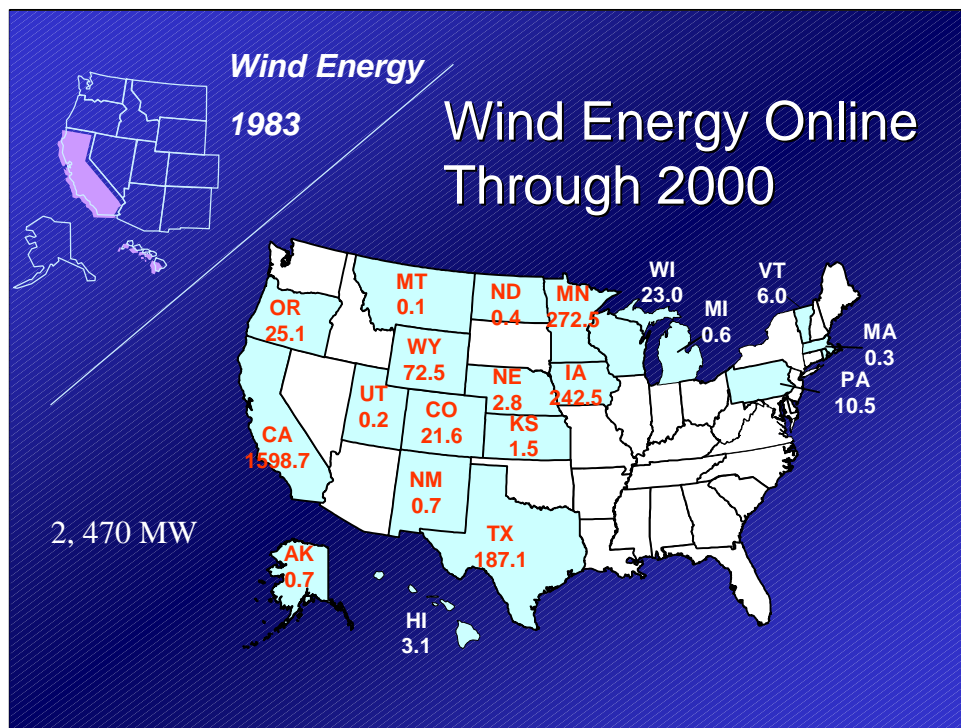


Source: REPP,
Worldwatch 1998/99

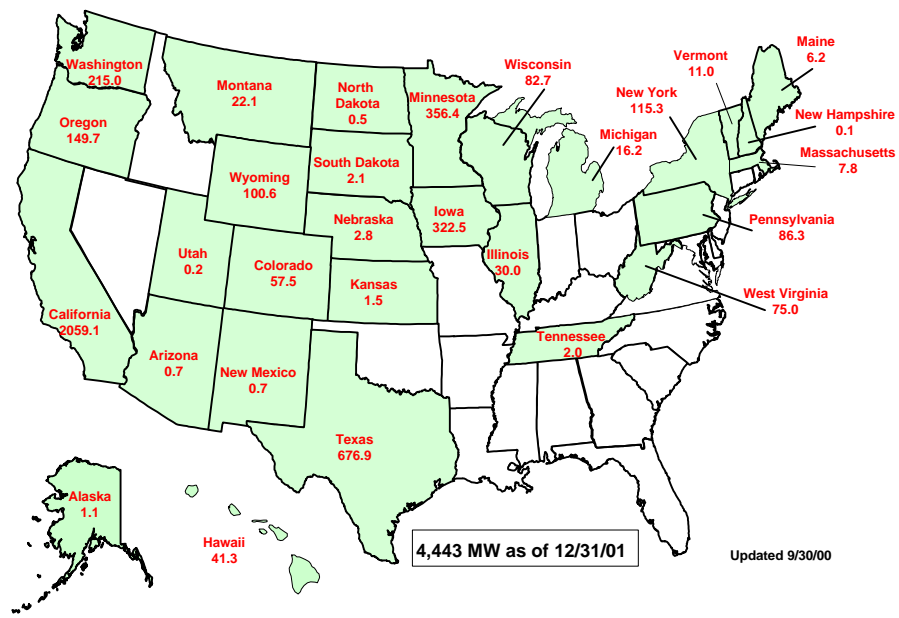
1999: An Outstanding Year for the Wind Industry Worldwide



- Almost 4,000 MW of New Capacity Worldwide
- 15,000 MW Cumulative Now Installed Globally



U.S. Wind Power - Expected by end of 2001 (MW)



Driving Forces Behind the Rebirth



- v State Policy
- v Electric Industry Competition
- v Wind's Steadily Improving Economics
- v Utility Experience and Perspective

Different Types of Wind Power

Water Pumper



**Customer-Owned
Small Generator**



**Single Large
Turbine**



Cluster Farm



**Offshore
Farm**

Slide 27:

[THIS IS A TRANSITION SLIDE THAT CAN BE USED ANYWHERE IN THE PRESENTATION. THERE IS NO COPY TO READ FOR THIS SLIDE.]

Large and Small are Different

Large Turbines – 100 kW to 1 MW

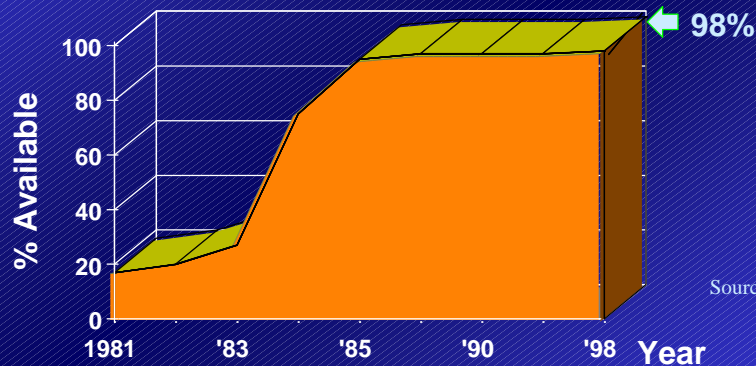
- v Installed in “wind farm” arrays
- v Provide power to utility grid
- v Require 13 mph average wind sites

Small Turbines – 0.5 to 100 kW

- v Installed in off-grid and facility-specific on-grid applications
- v Provide power using back-up generation or storage
- v Designed for reliability, low maintenance
- v Require 9 mph average wind sites



Availability of Better Wind Technology



Source: PG&E

Average Percent of Turbines Available
for Operation at Any Given Time

Slide 6:

Wind energy's increased maturity is also evident from the percentage of turbines in a wind plant that are available to generate power at any given time, a standard measure of generator reliability called "availability." Improved technology has helped wind turbine availability remain constant at more than 98% for the last decade. U.S. wind farm operators have become well-known for their extensive experience with day-to-day management of large wind facilities. As a result, they are finding demand for their unique skills and services worldwide.

Economies of Scale Drive Down Cost

	<u>1981</u>	<u>1998</u>
Rated Capacity	25kW	750kW
Rotor Diameter	10 meters	50 meters
Total Cost (\$000)	\$65	\$600
Cost Per kW	\$2,600	\$800
Output, MWh/year	45	2,500

56 x the energy at 9 x the cost!



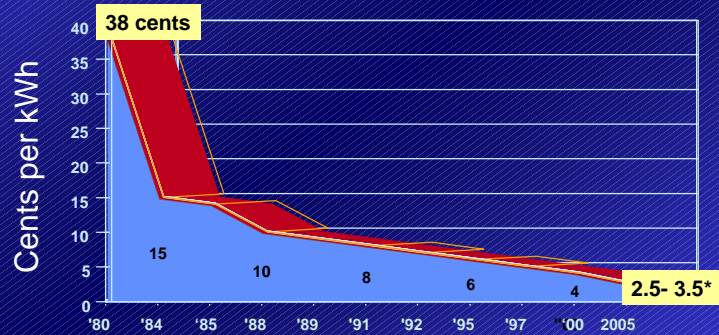
Slide 7:

Wind energy's dramatic technological advances are translated here to show how increased turbine size and greater turbine efficiency have helped bring down the costs of building wind projects and ultimately the cost to consumers.

In 1981 it cost \$2,600 per kilowatt to purchase a 25-kilowatt wind turbine. In just 18 years, the cost has dropped to \$800 per kilowatt for a much larger 750-kilowatt machine. As the line at the bottom of the chart points out, today's technology is providing 56 times the power at just 9 times the cost of early 80s wind turbines.

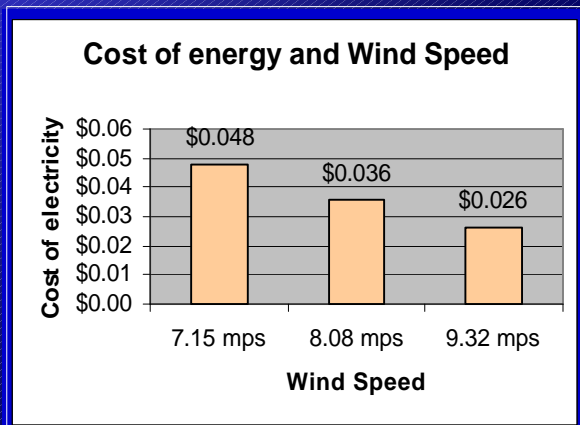
Wind Energy Cost

Cost of Wind-Generated Electricity 1980 to 2005,
Levelized cents/kWh



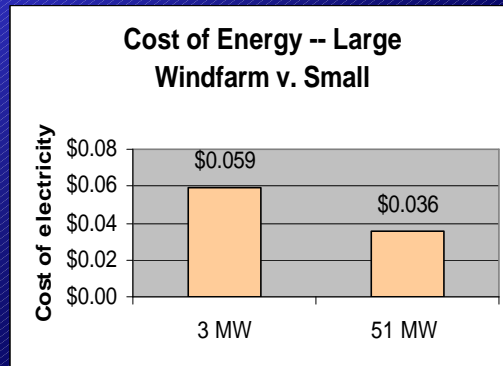
Assumptions: Levelized cost at "excellent" wind sites, large project size,
not including PTC (post 1994), costs in nominal cents/kWh.

Acquiring Wind Least-Cost: Wind Speed Matters



Assuming
the same
size project,
the **better**
the wind
resource,
the **lower**
the cost

Acquiring Wind Least-Cost: Project Size Matters



Assuming the same wind speed of 8.08 M/S, a large wind farm is more economical

Growing Utility Involvement with Wind Energy



- ✓ 175 Suppliers now offer a Wind-based Green Product in 25 States
- ✓ Planned in at least 4 more

Future Trends or Driving Forces in the Electric Industry

- v Increasingly Competitive Electric Industry
- v Increasingly Stringent Environmental Controls
- v Continued Movement Toward Distributed Generation
- v Growing Appreciation of Generation Portfolio Diversity

Wind - Natural Gas Compatibility

Wind

Low Operating Cost

High Capital Cost

Non-dispatchable

No Fuel Supply/Cost
Risk

No Emissions



Natural Gas

High Operating Costs

Low Capital Cost

Dispatchable

Fuel Supply/Cost Risk

Smog, Greenhouse
Gas Emissions

Market Barriers

- v Siting Issues
 - Avian
 - Noise
 - Aesthetics
- v Transmission
- v Intermittence

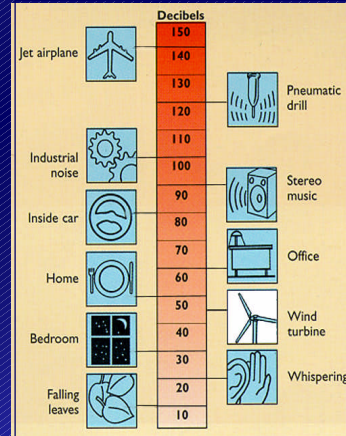


Market Barriers

Is Noise an Issue?

How Much Noise Do
Wind Turbines Make?

45 decibels
at 350 meters



Slide 20:

Technological advances have sharply reduced the level of noise from an operating wind farm. While turbine blades moving in the wind do produce a light “whoosh” sound, the noise has been rated at about 45 decibels at a distance of 350 meters, which is equivalent to outdoor nighttime noises usually heard in the country. Additionally, the noise is often masked by the background sounds of the wind.

In the permitting process for wind farms, noise should not be a significant concern because it is routinely dealt with through requirements that turbines be set back an appropriate distance from any nearby residences.

Federal Goals for Renewable Energy

- v Executive Order 13123
 - 2.5% of Federal electricity from green sources
- v Windpowering America
 - 5% of Federal electricity from wind by 2010
 - 5% of U.S. electricity from wind by 2020



Executive Order 13123

- v E.O. 13123, Greening of the Government through Efficient Energy Management was signed by President Clinton on June 3, 1999.
 - Section 204 - “Each agency shall strive to expand the use of renewable energy... **by purchasing electricity from renewable energy sources**”
 - Section 404c - “Agencies should **include provisions for the purchase of electricity from renewable energy sources** as a component of their requests for bids whenever procuring electricity.” Agencies may use savings from energy efficiency projects to pay the additional incremental costs of electricity from renewable energy sources”

Wind Powering America

Announced
June 1999



"Wind energy has been the fastest growing source of energy in the world during the past decade and now represents a major economic opportunity for the United States."

Wind Powering America will help us promote regional economic development, increase America's energy security, and protect our environment for generations to come."

Bill Richardson, Secretary of Energy

Goals:

- 5% of nation's electricity by 2020
- Double the states with 20 MW installed to 16 by 2005, and then to 24 by 2010
- 5% of Federal electricity use by 2010 (1,000 MW)

DOE Green Power Directive

- Secretary Richardson directed DOE to buy green power, April 20, 2000
- 3% of electricity needs from non-hydro renewables by 2005...7.5% by 2010
- In deregulated states, DOE will competitively select suppliers
- No increase in utility bill expected
- First Federal agency to make Department-wide commitment

Military is Key

- v DoD accounts for as much as 85% of the Federal energy use
- v Without significant participation by the military services, **Federal wind energy goals cannot be met**
- v There is currently no DoD policy encouraging military bases and commanders to participate in green energy purchases

Mechanisms for Federal Wind Energy Purchases

- v **Direct purchase of wind turbines**
 - Capital investment funds for large projects
 - Operating funds for small projects
 - Energy investment funds (e.g. DoD “ECIP”)
- v **Developer funding**
 - Energy Savings Performance Contracts
 - Other innovative contract arrangements (e.g. Ft. Bliss, TX)
- v Green energy purchases
- v Green “tags”

Existing Federal Wind Projects



San Clemente Island, California

- ✓ U.S. Navy island 53 miles off San Diego
- ✓ Diesel powered grid
- ✓ Average demand 850-950 kW
- ✓ Wind provides 14% of electricity annually



Ascension Island

- ✓ U.S. Air Force installation on British island in mid-Atlantic ocean.
- ✓ Prime diesel generation with rotary interconnect to British 50 hertz system
- ✓ Up to 10 added turbines planned



Camp Williams, UT (Utah National Guard)

- v One NEG Micon 225 kW turbine purchased through FEMP
- v Other funding from U.S. National Guard Bureau, Utah state energy office, and Utah National Guard
- v Installed March-May 2000
- v At least one additional turbine planned

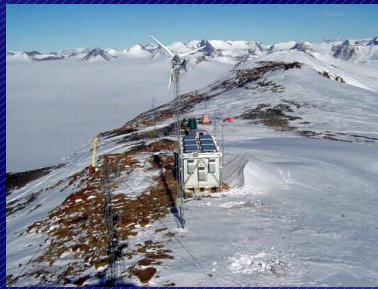


Planned On-site Projects

- v Navy planning additional turbines on SCI; considering turbines for San Nicholas Island, CA and Wallops Is., VA
- v Air Force planning up to 10 added turbines for Ascension Island; considering Vandenberg AFB, CA
- v Army considering Ft. Bliss, TX; White Sands Missile Range, NM; Ft. Huachuca, AZ

National Science Foundation, Antarctica

- v Two remote communications relay sites
- v Unmanned
- v Operated year round
- v Wind, PV, propane hybrids



Black Island

Mt. Newell

FAA Chandalar Lake, AK

- FAA aircraft navigation beacon at Chandalar Lake in Brooks Range, northeast AK.
- Accessible only by air.
- Previously powered by diesel generators--fuel flown in.
- Decided on an all-renewables system in 1999.
- Two Bergey 7.5 kW turbines on 30 m (100 ft) guyed-lattice towers, 5 kW solar array, 48 VDC sealed battery bank, switchgear, and two Trace sine wave inverters.



Mechanisms for Federal Wind Energy Purchases

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Green Energy Purchases

- v Clearly the WPA goal of 5% (1000 MW) of Federal wind energy by 2010 will not be met through Federal purchase of wind turbines
- v Several sizable Federal green energy purchases have already been announced
- v Significant opportunities exist for large Federal purchases of green energy and “green tags”

Colorado Federal Wind Purchase Initiative

- v Lead by Denver Federal Executive Board (DFEB)
 - DFEB represents over 130 federal agencies in metro area.
 - Worked in partnership with GSA, DOE Denver Regional Office, DOE Golden Field Office, NREL and EPA.
- v Goal - 10 MW wind purchase by federal facilities in Colorado through utility green pricing programs.
- v Request federal agencies to commit to purchase equivalent to 10-25% of load in order to meet 10 MW goal.

Leadership Opportunities

- v Demonstrate leadership in complying with renewable energy and greenhouse gas emission reduction provisions in federal Executive Order 13123
- v Demonstrate federal commitment to the community
- v Demonstrate environmental commitment - help meet air quality and health goals
- v Demonstrate good stewardship
- v Strengthen employee morale

Challenges to Federal Wind Energy Purchases

- ∨ Most Federal agencies are operating with fixed or declining budgets, especially for energy purchases.
- ∨ Despite the provisions of E.O. 13123 allowing expenditure of energy savings, most savings are owed to ESCO's or have been pledged to other programs or removed from the agencies' budgets

Results

- v Our success-- 31 commitments (10 MW)
- v The largest agency commitments
 - Ft. Carson Army - 4661 blocks
 - DOE Rocky Flats - 3000 blocks
 - DOI -USGS - 2000 blocks
 - EPA - 1670 blocks (100%)
 - NREL - 1651 blocks
 - VA Medical Center- 1443 blocks
 - US Mint - 1000 blocks

Recognition Ceremony and Press Conference

*April 27, 2000
Denver, Colorado*



Participating Agencies with the Department of Energy Secretary
Bill Richardson and group of children

Activities Since Announcement

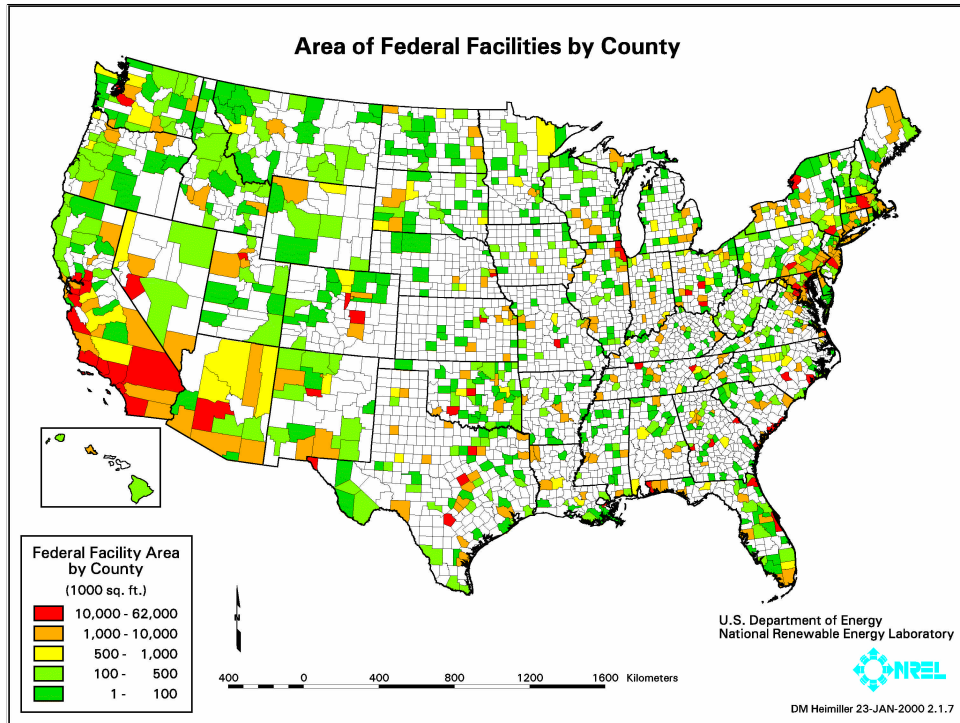
- √ DOE/NREL working with GSA to...
 - Turn commitments into contracts. “Reimbursable Work Authorization” (RWA) for agencies in leased space.
 - Find ways to pay for premium (a “revenue neutral” approach)
- √ Agencies encouraged to submit budget request to cover premium (per EO 13123 Section 301).
- √ Green Power Purchase Toolkit

- through energy efficiency, signing GSA/DESC alternative gas supply contract, WAPA allocations, etc.

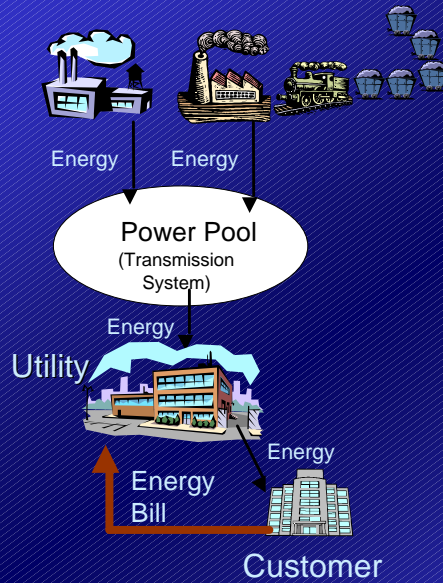
Includes documents such as process description, documents used (data spreadsheet, agency worksheet, letter of commitment form, agency presentation), renewable power information (maps, policy information, etc)

Work Remaining

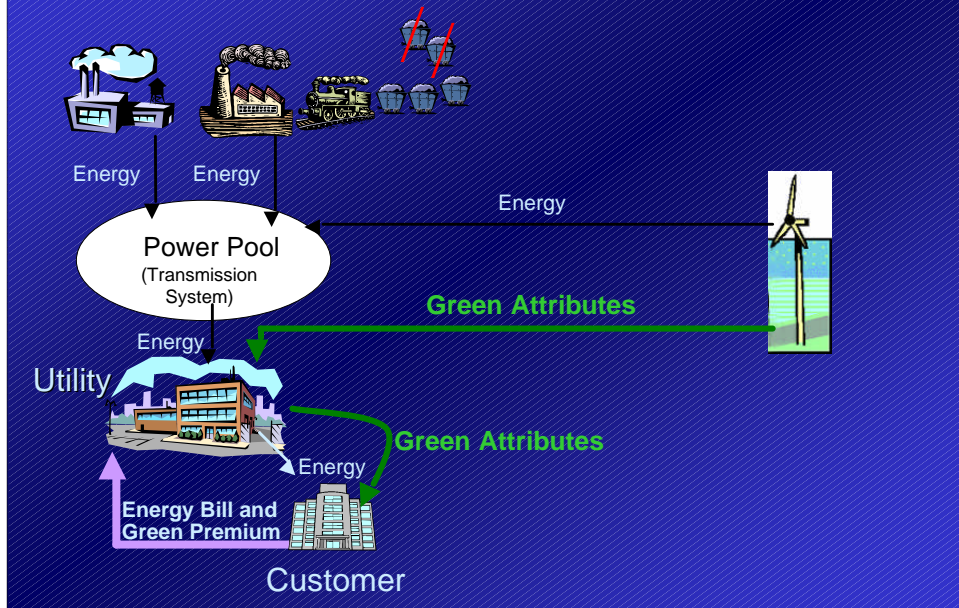
- v Increase the Denver commitment from 3% to 5-10%
- v Provide assistance in finding energy savings to offset cost of Wind Source
- v Turn informal commitments into signed contracts with utilities
- v Aggregated DOE purchase
 - 3% of DOE electricity
 - Equivalent to 60 MW of new wind capacity
- v Other Federal purchases



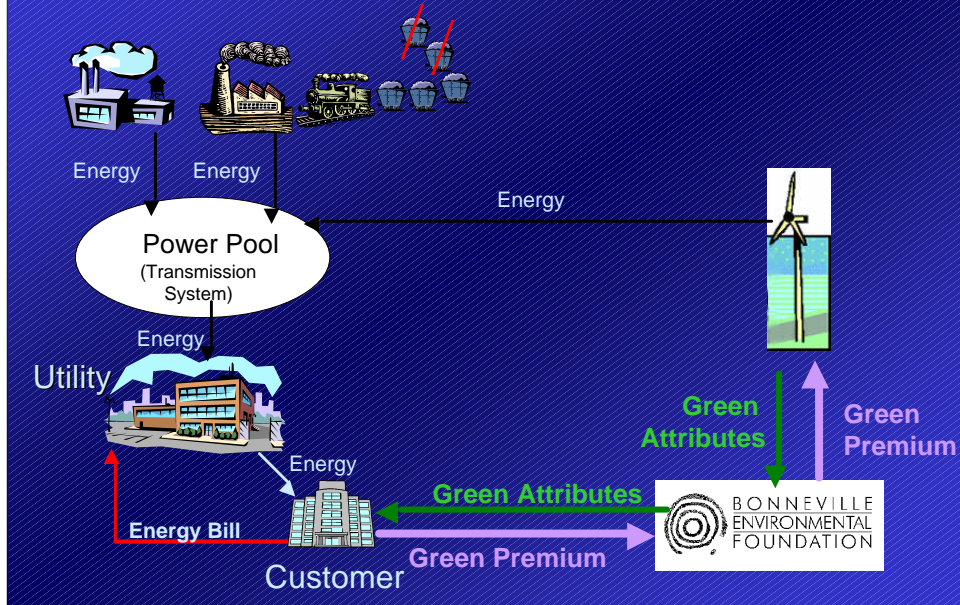
Traditional Power Transaction



Green Power Transaction



Green Tag Transaction



Green Power VS Green Tag

Green Power	Green Tag
• Purchased from utility or power marketer	• Purchased from green tag broker
• Only available in some areas	• Available anywhere
• Multiple transactions	• One transaction
• Premium = 5-2 cents/kWh	• Premium = 2.2-1.1 cents/kWh
• Energy & green attributes on same bill	• Energy bill unchanged; green premium paid to green tag broker
• Reliability & power quality don't change	• Reliability & power quality don't change

Questions?

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Ed_Cannon@nrel.gov

Web Sites

- v **FEMP Web Site** - www.eren.doe.gov/femp/
- v **EO 13123** - www.eren.doe.gov/femp/aboutfemp/exec13123.html
- v **GSA Green Power** - www.gsa.gov/pbs/centers/energy/green.htm
- v **Wind Powering America** - www.eren.doe.gov/windpoweringamerica/
- v **GeoPowering the West** - www.eren.doe.gov/geopoweringthewest/
- v **GSA Request for Proposals** - www.gsa.gov/pbs/xu/co1.htm
- v **DOD Request for Proposals** -
www.desc.dla.mil/main/a/electric/index.htm
- v **Green Power Network** - www.eren.doe.gov/greenpower/home.shtml
- 1) **Green Pricing Programs** -
www.eren.doe.gov/greenpower/pricing.shtml
- 2) **Competitive Green Power Products**
www.eren.doe.gov/greenpower/marketing.shtml